



# CANNIBALISM OF INVASIVE SPECIES FALL ARMY WORM *SPODOPTERA FRUGIPERDA* (J.E. SMITH) IN NASHIK DISTRICT MAHARASHTRA, INDIA

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## ABSTRACT:

In the present investigation “Cannibalism of invasive species fall army worm *investigation* by conducting survey and experiment during period of August to December of the year 2022 to find out the different larval stage (1to 6) exhibit same pattern of or differ in cannibalism behaviour. Among different range of cannibalism behaviour pattern was observed in 1<sup>st</sup> instar to 6<sup>th</sup> instar of *Spodoptera frugiperda*. The maximum percentage of cannibalism was present in early period of 6<sup>th</sup> instar of fall army worm. We also found that there was partial and complete cannibalization of fall army worm. During the invitro culture at room temperature exhibit larval mortality receptively 5%, 10% and 20%. Pupation occurs 80%, 50% and 10% in the respective treatment 1, 2 & 3.

**KEY WORDS:** Cannibalism, Fall Army Worm, *Spodoptera frugiperda*, Invasive species, KTHM collage

## INTRODUCTION:

*Spodoptera frugiperda* (J.E. Smith), popularly best known as the fall army worm, is an important Lepidopteran pest in the Americas. The pest has invaded Africa with the first detections being reported in central and western Africa in early 2016, and in late 2016 and 2017 in parts of southern, eastern and northern Africa. It became important during the mid-19th Century when it was reported attacking Maize, Sugarcane, Rice and Grasses in the southern USA (Hinds and Dew, 1915).

It normally overwinters successfully in the United States only in southern Florida and southern Texas. The fall army worm is a strong flier, and disperses long distances annually during the summer months. The maximum migration flight recorded for FAW was 1600 km (Rose et al., 1975).

In 2016 it was reported for first time from African continent in Nigeria, Sao Tome, Benin and Togo (Goergen, 2016). In India the pest was first reported in Karnataka on Maize crop in 2018 (ICAR-NBAIR, 2018). In Maharashtra first time reported in Tandulwadi village, Taluka Karmala, District Solapur by Dr. Ankush Chormule in month of September 2018. In Marathwada region, *Spodoptera frugiperda* (J.E. Smith) was reported by Dr. Bhede in Itlapur village from Parbhani, District on rabi sorghum in the month of November 2018.

This is the first record of the fall army worm *Spodoptera frugiperda* (J.E. Smith) on Bt cotton in India, so it is very necessary to be alert about the infestation of FAW on Bt cotton and should take proper preventive and curative measures for its management. (Dr. N K. Bhute, Assistant Entomologist. AICCIP, MPKV, Rahuri, 2019).

The fall army worm causes major damage to economically important cultivated grasses such as Rice, Sorghum and Sugarcane as well as Cabbage, Beet, Peanut, Soybean, Alfalfa, Onion, Cotton, Pasture Grasses, Millet, Tomato and Potato. A total 353 *Spodoptera frugiperda* larval host plants recorded belonging to 76 plant families, principally Poaceae (106), Asteraceae (31) and Fabaceae (31) (Montezano et al., 2018). The *Spodoptera frugiperda* is a cosmopolitan pest of the Maize crop (Wiseman, 1966). It feeds on all growth stages of Maize but most frequently in the whorl of young plants up to 45 days old.

*Spodoptera frugiperda* (J.E. Smith) larvae usually consume large amount of foliage and eventually destroys the growing point of the plant. Ovipositional preference and larval behaviour for this species within host plants greatly reduces susceptibility to many insecticides. Adults may deposit clusters of 10-500 eggs throughout the plant canopy, but often prefer to oviposit in the lower two-thirds of Cotton plants or whorls of corn or sorghum. First instars can be observed in an aggregate near the site of the egg mass, while late instars aggressively disperse within and across adjacent plants (Ali et al., 1989).

The newly hatched larvae immediately start feeding on the tissues, usually beginning with the tender portions. First instar larvae usually eat the green tissue from one side of the leaf, leaving the membranous epidermis on the other side intact. Older instars begin to make holes in the leaf and the fourth to sixth instars may completely destroy small plants and strip larger ones (Cruz, 1995). *Spodoptera frugiperda* (J.E. Smith) alone is responsible for causing millions of dollar losses to farmers around the world. In India, Maize, Bajra and sorghum are the sustenance crops grown by many marginal farmers while, the earnings from these crops are meagre. Yield reductions in Maize due to feeding of *Spodoptera frugiperda* (J.E. Smith) have been reported as high as 34.00 per cent (Williams and Davis, 1990).

However, the present investigation was planned accordingly after going through the in-vitro rearing and growth transitions larvae to adult, we found that there was big problem of cannibalization while rearing the *Spodoptera frugiperda* (J.E. Smith). After literature survey, where it was noticed that very little work has been done on the cannibalism of *Spodoptera frugiperda*.

## MATERIAL AND METHODOLOGY:

### 1. Survey and collection of fall army worm and identification

Based on the survey conducted from period of August-2022 to December-2022. In different localities of Nashik district such as Trimbakeshwar, Igatpuri, Sinnar, Deola and Dindori covering 25 village of different five tehsil of Nashik and fall army worm larvae were collected.

These collected Fall army worm larvae rear in- vitro condition at room temperature and all stages were observed from larvae, pupa, adult. These all stages are continuous observation and for critical examination to identify distinct morphological characters of the pest. *Spodoptera frugiperda* presence was determined by using the presence of larvae on leaves or in leaf funnel identifiable with the inverted 'Y'- Shape in head and a set of four dots forming a square on upper surface of the last segment of its body, irregular damage (cuts) on leaves and presence of egg masses.

The distinguishing feature of fall army worm is there are six instar larvae where the first instar larvae are green with a black head, this head will turn orangish in the second instar. During the third instar dorsal surface of the body become brownish and lateral white line begin to form. In the fourth to sixth instar, the head is reddish brown, moulted with white, and the brownish body bear white subdorsal and lateral line. The face of mature larvae is marked with a white inverted "Y" shaped and epidermis of larvae is rough or granular in texture when examine closely. (Prasanna et al.,)



Figure 1. A. Collection of fall army worm in Maize crop at Sinner, Nashik. B. four dark spot arranged in square on upper last abdominal segment. C. Inverted 'Y' shaped on head.

## 2. Cannibalism:

Newly field collected fall army worm larvae were separated on the basis of their morphological characteristics and also based instar. After 24 hrs at room temperature these were divided in to three different group in three different group this are control diet, reduced food quality, reduced food availability. Larvae in control diet (Treatment 1) about (n=40) is provided with the excess control diet with every day food and water supply. Larva (n=40) in reduced food quality (Treatment 2) provided with reduced food and premature maize corn and water was in normal quantity. Larva in reduced food availability (Treatment 3) provided with starvation period 14 hrs. All these replicates were examined daily mortality, cannibalism and pupation.



Figure 2. E.1. Control diet supply, treatment 1, E.2. Reduced food quality, Treatment 2 and E.3. Starvation food maize leave were not supply treatment 3.

A sufficient and fresh maize leave and water provided for treatment 1, food quality is reduced in treatment 2 and in starvation was followed in treatment 3. after 24hrs, 48hrs, 72hrs, 96hrs & 120hrs. and the observation taken with respect to the cannibalism, mortality and pupation. If larvae were cannibalized then it is missing from the recoded. If mortal is present and recorded in mortality. The number of pupations was also recoded. These data were express in the percentage of mortality and percentage of cannibalism and percentage of pupation. Cannibalism behaviour were also examined in three treatments.

## RESULT AND DISCUSSION:

### 1. Survey and collection of Fall army worm and identification:

The invasive species *Spodoptera frugiperda* is a polyphagous lepidopteran pest it can be destructive during the vegetative stages of crop and when the temperature is 10°C feeding on the large number of the leave and steam of more than 100 of plant species where these all are economical important cultivated crops including Maize, millets, wheat, potato, soyabean, cowpea, peanuts, sorghum, Rice, Sugarcane, even also vegetable and cotton. (CABI.2017; Poque, 2002). The life cycle of *Spodoptera frugiperda* went through the egg, sixth larval instar, pupa and adult. The main distinguished feature from larva to pupa is presented below.





Figure 3. F. Larval stage 1<sup>st</sup>- 2<sup>nd</sup> instar in maize crop, G. Larval stage 3<sup>rd</sup> -4<sup>th</sup> instar, H. Larval stage 5<sup>th</sup> – 6<sup>th</sup> instar and I. Pupa.

### Larvae and pupa:

Table 1. Represent the instar, body length marking and nature of damage to maize crop

Instar	Body length (mm)	Colouring	Markings	Nature of damage
1-2	1.5 -3.5	Green with a black head	None	Damage to soft leave plant tissue and whorl of maize plant
3-4	6-10	Dorsal area tan colour, ventral area white/ being stripes visible	Four dark pinacula or raised spot arranged in square on the 8 <sup>th</sup> abdominal segment and trapezoid on the 9 <sup>th</sup> .	Feeding after from hatching to pupation and causes worst damage fourth to sixth instar larval stages.
5-6	15 – 40	Light tan, green, black	Four dark pinacula or raised spot arranged in square on the 8 <sup>th</sup> abdominal segment and trapezoid on the 9 <sup>th</sup> .	Damage to maize whorl, stem and cob through extensive feeding 24 hrs.
Pupa	12-20 & 43 in width	Reddish-brown	Pupation normally takes place in soil. Male and female pupa have different in size and shape.	Non feeding stage.

**2. Cannibalism:** The older larvae of fall army worm exhibit a cannibalistic behaviour on other smaller larvae, when they co-occur. Cannibalism, mortality and pupation was found to account for treatment 1 (control food), treatment 2(reduced food quality) and treatment 3 (starvation) observed.

The percentage of mortality, cannibalism and pupation was calculated for each treatment by dividing number of larvae dead/ cannibalized /pupation by number of larvae initially present. This following formula,

$$\text{Percentage of Mortality} = \frac{\text{Number of dead FAW larvae}}{\text{Total number FAW larvae}} \times 100$$

$$\text{Percentage of Cannibalism} = \frac{\text{Number of dead FAW larvae Cannibalized}}{\text{Total number FAW larvae}} \times 100$$

$$\text{Percentage of Pupation} = \frac{\text{Number of dead FAW Pupation}}{\text{Total number FAW larvae}} \times 100$$

The percentage of cannibalism, mortality was observed were expressed in percentage in table 2.

Table 2. Percentage of Mortality, Cannibalism and pupation.

Treatment	Mortality in percentage %	cannibalism percentage %	percentage of pupation %
Treatment 1	5	15	80
Treatment 2	10	40	50
Treatment 3	20	70	10

1. In the control food that is treatment 1, reduced food quality 2, and reduced food 3 show mortality about 5%, 10% and 20% this represented following graph.

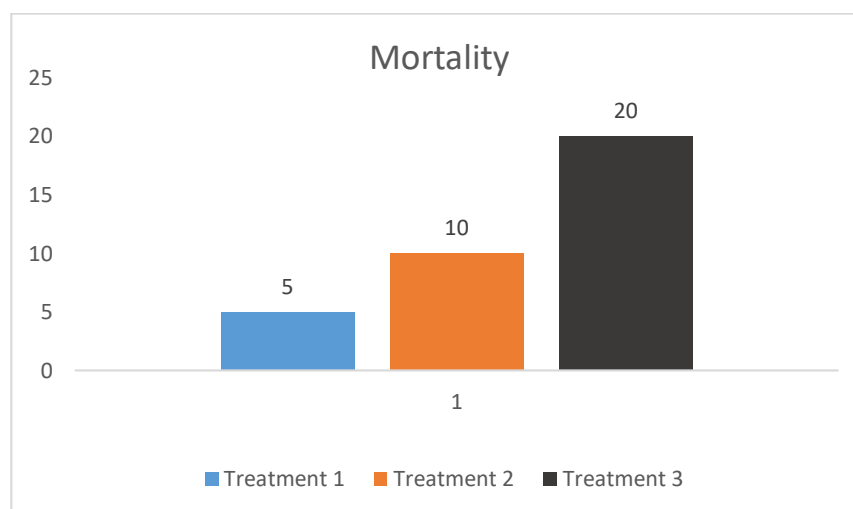


Figure 4. mortality percentage of treatment1, 2 and 3.

The cannibalism of fall army worm larvae shows the maximum in the starvation treatment 3 and minimum in treatment1. These represented in following graph.

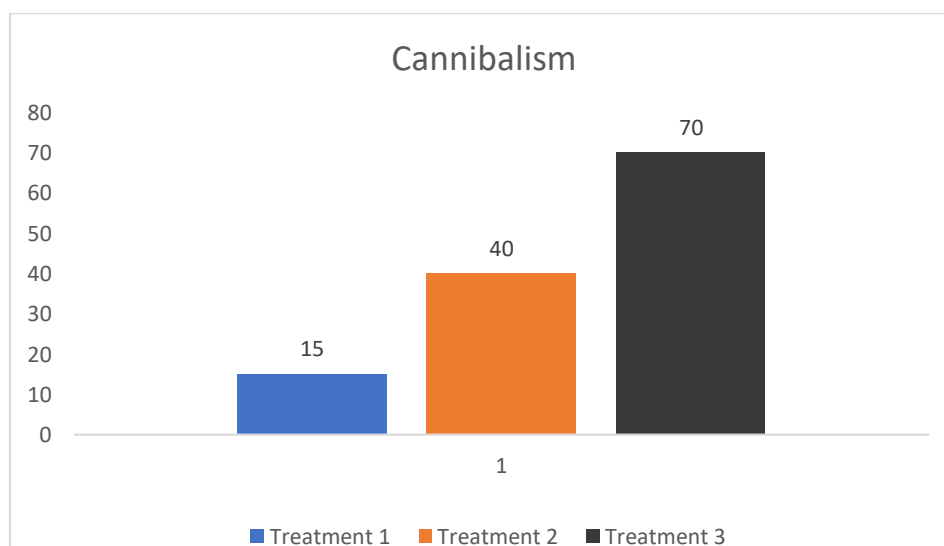


Figure 5. Cannibalism of treatment 1, 2 and was 15%, 40% & 70%.

The cannibalism of larvae of 1<sup>st</sup> and 2<sup>nd</sup> instar does not show cannibalism because they generally feed on the soft tissue of plant leave and new leaves of maize crop. In the 1<sup>st</sup> and 2<sup>nd</sup> instar does not feed in older larvae of *Spodoptera frugiperda*. The rate of cannibalism increases in nutritionally poor environment such as reduced food quality and starvation. Food quality and quantity was change then fall army worm require the additional food source. The rate of cannibalism was increase in treatment 2<sup>nd</sup> and 3<sup>rd</sup> as respectively 40% and 70%.

### Cannibalism behaviour of Fall army worm:

The first and second instar does not reveal cannibalism and the proportion of Cannibalism increased from third to fifth instar stages, with a decline sixth instar. The highest rate of cannibalism in mature larval stages of insect when compare to immature larval stage. In 1<sup>st</sup> and 2<sup>nd</sup> cannibalism was absent, 3<sup>rd</sup> and 4<sup>th</sup> instar larvae have partial cannibalism and 5<sup>th</sup> and 6<sup>th</sup> instar show the complete cannibalism. In the partial or incomplete cannibalism, the fall army worm larvae do not feed on head of another fall army worm larvae because head is hard and more sclerotization (Chitinous). In case of 5<sup>th</sup> and 6<sup>th</sup> instar larvae show complete cannibalization, its full larvae were eaten by another fall army worm larvae. The highest rate of Cannibalization in 5<sup>th</sup> and early 6<sup>th</sup> instar larvae. The rate of cannibalization decreases in late sixth instar larvae stage and revealing decline of food consumption and become less active getting ready for the pupation. The highest survival of mature instar and larger body size may increase demand of food if food reduced of starvation, then week, small and immature larvae cannibalized first as compare to strong, large and mature instar stage.

The cannibalism during the larval stage of development may confer fitness benefit to removal of the potential competitors, reduction in the probability attracting predators and thus increased survival, development rate and fecundity rate. However, if larval cannibalism is viewed in the perspective of self - regulating measure of population, this natural phenomenon can limit population size while suppressing outbreaks. Most importantly larval cannibalism of can be used as a natural biological control of economical important larval pest.



Figure 6. J. competition for cannibalism in fall army worm larvae, K. fall army worm larvae initially cannibalized by another larvae, L. 5<sup>th</sup> instar cannibal 3<sup>rd</sup> instar larvae, M. Complete cannibalization feed on head of fall army worm larvae and N. Partial or incomplete cannibalization because only head remain.

### Pupation:

The pupal stage is third inactive, non-feeding and non-locomotory stage of life cycle of *Spodoptera frugiperda* species. There are some basic differences between in male and female pupae in size and shape. Male pupa is smaller than female and genitalia difference. Pupa are oblect, initially green then turning brown and darkened near adult enclosion. The larval period depends on environmental condition from 8- 30 days. After compilation pupal period followed by the adult emergence. In present investigation the pupation occurs in treatment of 1, 2 and 3 as 80%, 50% and 10%. The rate of pupation in control food diet, reduced up 50% in reduced food quality and minimum in starvation is 10%. This also represented in the following graph.

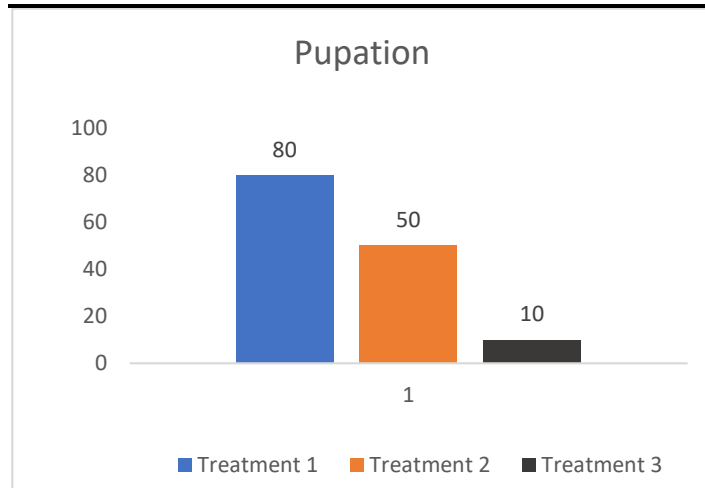


Figure.7. Graph of pupation occur in treatment 1, 2 and, 3.



Figure.8. Pupa of fall army worm.

## CONCLUSION:

In the present study confirmed cannibalism behaviour amongst the same species of *Spodoptera frugiperda*. The cannibalism behaviour was associated with the developmental stages of fall army worm 1<sup>st</sup> and 2<sup>nd</sup> larval instar do not show cannibalism and from 3<sup>rd</sup> to 6<sup>th</sup> instar show cannibalism. The maximum cannibalism present in 5<sup>th</sup> instar and rate of cannibalism reduces from late 6<sup>th</sup> instar stage because of less active and undergoes for pupation.

The rate of mortality and pupation generally occur in normal and control development of the fall army worm was not negligible. The cannibalistic behaviour of *Spodoptera frugiperda* affect the ecological behaviour between organism and system, especially between host and its natural enemies. There for the behaviour must better understood biological control measure for serious pest

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